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# Present and further researches for robust supply chain design

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## Robust Supply Chain설계에 관한 연구현황 및 방향

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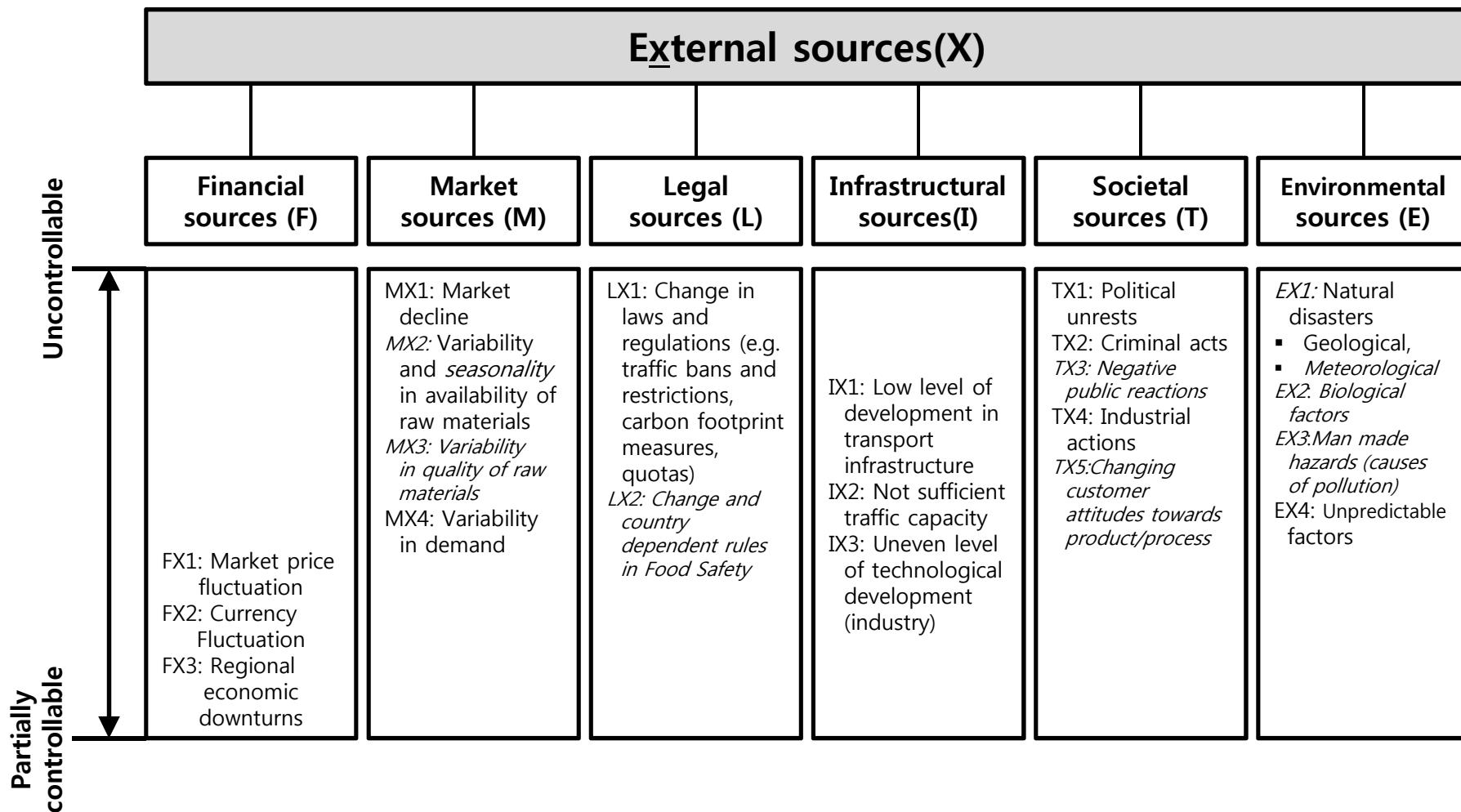
# Introduction

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- Introduction
  - An Uncertainty is inherent feature of supply chain and it can be appeared variety of situations in the internal and external supply chain.
  - Supply chain can't fulfill the inherent feature when an uncertainty obstructs the flow of information, raw material, finance and disruption of supply chain network.
  - After years of emphasis on responsiveness businesses is now experiencing their uncertainty to supply chain so there is a need for an integrated framework to support the analysis and design of robust supply chains.
- Purpose of the research
  - The purpose of this research is to define the distinct meaning of robust supply chain and propose the further research area for strategic design of supply chain to perform the inherent feature of supply chain under uncertainty.

# External and internal sources of Uncertainty

Fig. 1. External source of uncertainty (J. V. Vlajic et al. 2011)



# External and internal sources of Uncertainty

Fig. 2. Internal source of uncertainty (J. V. Vlajic et al. 2011)

Internal sources: Supply chain (S) or Company (C) related				
	Managed system (D)	Infrastructural sources(I)	Societal sources (T)	Environmental sources (E)
Partially controllable	Supply chain related (S)	<p>DS1: Product related hazards            DS2: Heterogeneous raw material (quality)            DS3: Complexity of supply chain network            DS4: One key business partner            DS5: Sophisticated equipment/Infrastructural restrictions</p>	<p>GS1: Strict requirements from key customers            GS2: Low reliability of chain partners            GS3: Lack of control in supply chain (e.g. for outsourced activities)            GS4: Lack of risk management and recovery planning initiatives along the chain</p>	<p>IS1: Lack of infrastructure to support information sharing            IS2: Lack of information visibility            IS3: Varying ICT standards used in supply chain</p>
	Company related (C)	<p>DC1: Low reliability of equipment            DC2: Product characteristics            DC3: Inventory related problems (perishability)            DC4: Low quality of (intermediate or final) products            DC5: Lack of capacity            DC6: Increasing product assortment</p>	<p>GC1: Limited control actions            GC2: Subjective decision making            GC3: Non-accurate forecasting            GC4: Lack or no sufficient attention to risks and disturbances management            GC5: Rigid planning (all levels)</p>	<p>IC1: Lack or no adequate decision support system            IC2: Slow data transfer and processing            IC3: Late detection of disturbances            IC4: Lack of data about disturbances            IC5: Inaccuracy of data            IC6: Not sufficient data analysis(disturbances)</p>

# Definition of robust supply chain

Table. 1. Definitions of robustness in supply chain

<b>Definitions of robustness in supply chain</b>	<b>Authors</b>
The ability of a network to cope with changes in the competitive environment without resorting to changes in the network structure.	Ferdows (1997)
The system's ability to resist an accidental event and return to do its intended mission and retain the same stable situation as it had before the accidental event.	Asbjørnslett and Rausand (1999)
The ability of a supply chain design to find a supply chain configuration that provides robust and attractive performance while considering many sources of uncertainty.	Mo and Harrison (2005)
The ability of supply chain to maintain a given level of output after a failure.	Bundschuh et al. (2006)
The supply chains ability to withstand external and internal shocks.	Chandra and Grabis (2007)
The ability of a supply chain network to carry out its functions despite some damage done to it, such as the removal of some of the nodes and/or links in a network.	Dong (2006) Dong and Chen (2007)

# Introduction for robust supply chain strategies

Table. 2. Introduction for robust supply chain strategies

<b>Strategic robust supply chain</b>	
Robust supply chain design: a strategic approach for exception handling. (Roshan Gaonkar et al. 2003)	This paper proposed the framework for partner selection in the exception events such as undesirable events(e.g. earthquake, natural disasters). This paper also analyzed the impact of failure event in the supply chain.
A conceptual framework for robust supply chain design under demand uncertainty. (Mo and Harrison, 2005)	This paper proposed 6 measurements of the robustness of a supply chain. (Minimum total expected cost, Minimum variance of the total cost, Minimum total deviation from firm's target value, Maximum mean-variance criterion, Minimum of the maximum deviation, Multiple criteria)
Robust strategies for mitigating supply chain disruptions. (Christopher S. Tang, 2006)	This paper proposed and analyzed 9 efficient, resilient and robust strategies with main objective and benefits for mitigating supply chain disruption. This paper also proposed 3 performance criteria for robust supply chain. (Cost versus benefits, Strategic fit, Proactive execution)
The design of robust value-creating supply chain networks: a critical review. (Walid Klibi et al. 2010)	This paper classified and defined type of uncertainties. This paper also proposed developmental direction in supply chain network design such as robustness, responsiveness and resilience.
A framework for designing robust food supply chains. (Jelena V. Vlajic et al. 2011)	This paper proposed strategic alternatives for various supply chain scenarios related internal and external uncertainty.

# Classification of network design for robust supply chain

Table. 3. classification of performance measure in robust supply chain

<b>Performance measure of robust supply chain</b>								<b>Model type</b>
	Expected total cost	Cost variability	Model infeasibility penalty	Minimization of the risk (Uncertainties)	Expected disruption cost	Minimization of shortage cost	Probability of returns	
M. Bundschuh et al. 2003	✓							Deterministic analytical
Mo and Harrison, 2005	✓							Stochastic analytical
A. Azaron et al. 2008	✓			✓				Stochastic analytical
F. Pan et al. 2009	✓	✓	✓					Stochastic analytical
W. Klibi et al. 2009	✓	✓		✓				Deterministic analytical
C. Wei et al. 2009	✓			✓			✓	Deterministic analytical
J. Xu et al. 2009	✓			✓		✓		Simulation
A. Shukla et al. 2010	✓				✓			Deterministic analytical

# Classification of network design for robust supply chain

Table. 4. Classification of uncertainties in robust supply chain

	<b>Uncertainties of robust supply chain</b>						
	Disruption of supply chain	Demand uncertainty	Downside risk	Weighted of Acceptable-risk	Weighted of Serious-risk	Uncertainty of returns	Uncertainty of variable cost
M. Bundschuh et al. 2003	√						
Mo and Harrison, 2005		√					
A. Azaron et al. 2008			√				
F. Pan et al. 2009		√					
W. Klibi et al. 2009				√	√		
C. Wei et al. 2009		√				√	
J. Xu et al. 2009		√					√
A. Shukla et al. 2010	√	√					

# Classification of network design for robust supply chain

Table. 5. Classification of decision variables in robust supply chain

	Decision variables									
	Production	Amount of product transportation	Amount of raw material transportation	Inventory of Production	Inventory of raw material	Amount of backorder	Unfulfilled demand	Plant operation	Warehouse operation	Amount of outsourcing
M. Bundschuh et al. 2003	√	√	√							
Mo and Harrison, 2005		√	√					√	√	√
A. Azaron et al. 2008	√	√		√					√	
F. Pan et al. 2009	√	√	√	√	√	√	√			
W. Klibi et al. 2009		√					√	√	√	
C. Wei et al. 2009		√	√				√		√	
J. Xu et al. 2009	√	√	√	√	√		√			
A. Shukla et al. 2010		√		√			√		√	

# Conclusion

- Conclusion
  - We could determine external and internal source of uncertainty and define the meaning of robustness in supply chain.
  - We also determine how the research related to robust supply chain has been developed in performance criteria, uncertainty and decision variable in the past.
- Future research
  - In the future, we need to develop the specific strategy for robust supply chain under each uncertainty source such as Environmental and infra structural etc.
  - We need to create new performance criteria to estimate more accurately robustness in the supply chain.
  - We also need to consider about decision variables for strongly designed robust supply chain under variety of uncontrolled uncertainty.

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